

CLAIMS

1. A user interface for a computer-implemented Multi-Planar Reformatting (MPR) system for allowing a user to define and view a curve through a three-dimensional volume data set, comprising:
5 first, second and third display areas in which are displayed three orthogonal MPR images of the volume data set;
a curve drawing tool to allow a user to define a curve through the volume data set, at least part of the curve being displayed in projected format on each of the MPR
10 images;
a plurality of selectable icons each representing a direction substantially normal to a plane parallel to one of the MPR images, using which the user can select an approximate direction to be taken by the curve through the volume data set; and
a fourth display area, in which is displayed, after the user has defined at least
15 part of the curve, a curve-related MPR image through the volume data set related to one or more positions along the curve.
2. A user interface according to claim 1, wherein the plurality of selectable icons are displayed in the fourth display area before the user begins to define the curve, and
20 removed from the fourth display area and replaced with the curve-related MPR image after the user has defined at least part of the curve.
3. A user interface according to claim 1 or claim 2, wherein each icon comprises an image representing one of the orthogonal MPR images overlain with a generic
25 indicator of a direction to be taken by the curve which is substantially orthogonal to one of the other two orthogonal MPR images.
4. A user interface according to claim 3, wherein the generic indicator comprises a curved line and a representation of curvature of the orthogonal MPR image.

5. A user interface according to claim 3 or claim 4, wherein the image comprised in each icon is a thumbnail version of the relevant orthogonal MPR image.

5 6. A user interface according to claim 3 or claim 4, wherein the image comprised in each icon is a generic representation of the relevant orthogonal MPR image.

7. A user interface according to claim 6, wherein the generic representation of the relevant orthogonal MPR image is selected from a group of generic representations
10 according to user input or tags associated with the three-dimensional volume data set.

8. A user interface according to any one of claims 1 to 7, wherein the plurality of selectable icons comprises six icons each representing one of six possible combinations of a plane parallel to one of the orthogonal MPR images and a direction
15 substantially normal to a plane parallel to one of the other two MPR images, the six icons being individually selectable to allow the user to select both a direction to be taken by the curve, and a plane parallel to one of the MPR images.

9. A user interface according to claim 8, wherein the curve-related MPR image
20 shown in the fourth display area is a curved MPR image having a view direction substantially normal to the selected plane.

10. A user interface according to any one of claims 1 to 7, wherein the plurality of selectable icons comprises six icons each representing one of six possible
25 combinations of a plane parallel to one of the orthogonal MPR images and a direction substantially normal to a plane parallel to one of the other two MPR images, the six icons being grouped in selectable pairs, each pair having a common direction to be taken by the curve, to allow the user to select a direction to be taken by the curve.

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11. A user interface according to claim 10, wherein the curve-related MPR image shown in the fourth display area is a cross-curve MPR image showing an image perpendicular to the curve at a selected position.

5 12. A user interface according to claim 10 or claim 11, wherein after the curve has been defined, the selected pair of icons can be redisplayed in the fourth display area as individually selectable icons to allow the user to select a plane parallel to one of the MPR images, and after selection the fourth display area shows a curved MPR image having a view direction substantially normal to the selected plane.

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13. A user interface according to any one of claims 1 to 7, wherein the plurality of selectable icons comprises three icons each representing one of three directions, each direction being substantially normal to a plane parallel to one of the MPR images, the three icons being individually selectable to allow the user to select a direction to be
15 taken by the curve.

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14. A user interface according to claim 13, wherein the curve-related MPR image shown in the fourth display area is a cross-curve MPR image showing an image perpendicular to the curve at a selected position.

15. A user interface according to claim 13 or claim 14, wherein after the curve has been defined, two icons can be displayed in the fourth display area, each icon representing one of the two planes parallel one of the orthogonal MPR images and orthogonal to the plane normal to the selected direction, the icons being individually
25 selectable to allow the user to select a plane parallel to one of the MPR images, and after selection the fourth display area shows a curved MPR image having a view direction substantially normal to the selected plane.

16. A user interface according to any one of claims 9, 12 or 15, wherein the orthogonal MPR image which is substantially normal to the selected direction of the curve further shows a manipulatable tool which can be manipulated by the user to control rotation of the view direction about the curve.

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17. A user interface according to claim 16, wherein the manipulatable tool comprises one or more arcs along which the view direction can be moved.

18. A user interface according to claim 17, wherein the manipulatable tool further
10 comprises one or more lines or arrows indicating the current view direction.

19. A user interface according to any one of claims 16 to 18, wherein rotation of the view direction causes the curved MPR image displayed in the fourth display area to be updated such that the curved MPR image is orientated according to a clinical
15 standard.

20. A user interface according to any preceding claim, wherein the two orthogonal MPR images which are substantially parallel to the selected direction of the curve show all of the curve in projected format.

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21. A user interface according to any preceding claim, wherein the orthogonal MPR image which is substantially normal to the selected direction of the curve shows a part of the curve in projected format, comprising portions of the curve lying within a predetermined thickness of the volume data set.

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22. A user interface according to any preceding claim, wherein the projected format of the curves comprises a plurality of graphic markers marking points along the curve, and line segments connecting the graphic markers of adjacent points.

23. A user interface according to claim 22, wherein the graphic markers have different designs to indicate the distance through the volume data set of the points from the plane of the orthogonal MPR image.

5 24. A user interface according to claim 22 or claim 23, wherein the graphic markers are movable and deletable to allow the user to redefine the curve.

25. A computer program product carrying machine-readable instructions for implementing a Multi-Planar Reformatting (MPR) system, the system having a user
10 interface according to any one of claims 1 to 24.

26. A computer system comprising:

a Picture Archiving and Communication System having memory for storing three-dimensional volume data sets;

15 image processing software operable to perform Multi-Planar Reformatting image processing on the volume data sets and having a user interface according to any one of claims 1 to 24; and

one or more workstations operable to access the memory and retrieve the three-dimensional volume data sets, and implement the image processing software.

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27. A method of presenting a computer-implemented Multi-Planar Reformatting (MPR) system to a user, the system operable to allow a user to define and view a curve through a three-dimensional volume data set, the method comprising:

25 displaying three orthogonal MPR images of the volume data set in first, second and third display areas;

displaying a plurality of selectable icons each representing a direction substantially normal to a plane parallel to one of the MPR images;

allowing a user to select an approximate direction to be taken by the curve through the volume data set by selecting one or more of the icons;

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allowing a user to define a curve through the volume data set;
displaying at least part of the curve in projected format on each of the MPR
images;

deriving a curve-related MPR image through the volume data set related to one
5 or more positions along the curve; and
displaying the curve-related MPR image in the fourth display area.

28. A method according to claim 27, wherein the plurality of selectable icons are
displayed in the fourth display area, and removed from the fourth display area before
10 the curve-related MPR image is displayed.

29. A method according to claim 27 or claim 28, wherein each icon comprises an
image representing one of the orthogonal MPR images overlain with a generic
indicator of a direction to be taken by the curve which is substantially orthogonal to
15 one of the other two orthogonal MPR images.

30. A method according to claim 29, wherein the generic indicator comprises a
curved line and a representation of curvature of the orthogonal MPR image.

20 31. A method according to claim 29 or claim 30, wherein the image comprised in
each icon is a thumbnail version of the relevant orthogonal MPR image.

32. A method according to claim 29 or claim 30, wherein the image comprised in
each icon is a generic representation of the relevant orthogonal MPR image.

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33. A method according to claim 32, wherein the generic representation of the
relevant orthogonal MPR image is selected from a group of generic representations
according to user input or tags associated with the three-dimensional data set.

34. A method according to any of claims 27 to 33, wherein the plurality of selectable icons comprises six icons each representing one of six possible combinations of a plane parallel to one of the orthogonal MPR images and a direction substantially normal to a plane parallel to one of the other two MPR images, the six
5 icons being individually selectable to allow the user to select both a direction to be taken by the curve, and a plane parallel to one of the MPR images.

35. A method according to claim 34, wherein the curve-related MPR image is a curved MPR image having a view direction substantially normal to the selected plane.

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36. A method according to any one of claims 27 to 33, wherein the plurality of selectable icons comprises six icons each representing one of six possible combinations of a plane parallel to one of the orthogonal MPR images and a direction substantially normal to a plane parallel to one of the other two MPR images, the six
15 icons being grouped in selectable pairs, each pair having a common direction, to allow the user to select a direction to be taken by the curve.

37. A method according to claim 36, wherein the curve-related MPR image is a cross-curve MPR image showing an image perpendicular to the curve at a selected
20 position.

38. A method according to claim 36 or claim 37, and further comprising:
removing the curve-related MPR image from the fourth display area;
redisplaying the selected pair of icons in the fourth display as individually
25 selectable icons;

allowing the user to select a plane parallel to one of the orthogonal MPR images by selecting one of the icons;

deriving a curved MPR image through the volume data set having a view direction substantially normal to the selected plane;

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removing the icons from the fourth display area; and
displaying the curved MPR image in the fourth display area.

39. A method according to any one of claims 27 to 32, wherein the plurality of
5 selectable icons comprises three icons each representing one of three directions, each
direction being substantially normal to a plane parallel to one of the MPR planes, the
three icons being individually selectable to allow the user to select a direction to be
taken by the curve.
- 10 40. A method according to claim 39, wherein the curve-related MPR image is a
cross-curve MPR image showing an image perpendicular to the curve at a selected
position.
41. A method according to claim 39 or claim 40, and further comprising:
15 removing the curve-related MPR image from the fourth display area;
displaying in the fourth display area two individually selectable icons, each
icon representing one of the two planes parallel one of the orthogonal MPR images
and orthogonal to the plane normal to the selected direction;
allowing the user to select a plane parallel to one of the orthogonal MPR
20 images by selecting one of the icons;
deriving a curved MPR image through the volume data set having a view
direction substantially normal to the selected plane;
removing the icons from the fourth display area; and
displaying the curved MPR image in the fourth display area.
- 25 42. A method according to any one of claims 35, 38 and 41, and further
comprising:

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displaying on the orthogonal MPR image which is substantially normal to the selected direction of the curve a manipulatable tool for controlling rotation of the view direction;

allowing the user to manipulate the tool to rotate the view direction;

5 re-deriving the curved MPR image in accordance with the rotated view direction; and

displaying the re-derived curved MPR image in the fourth display area.

43. A method according to claim 42, wherein the manipulatable tool comprises
10 one or more arcs along which the view direction can be moved.

44. A method according to claim 43, wherein the manipulatable tool further comprises one or more lines or arrows indicating the current view direction.

15 45. A method according to claim 42 or claim 43, wherein the re-derived curved MPR image is displayed such that it is orientated according to a clinical standard.

46. A method according to any one of claims 27 to 45, wherein all of the curve is displayed in projected format on the two orthogonal MPR images which are
20 substantially parallel to the selected direction of the curve.

47. A method according to any one of claims 27 to 46, wherein part of the curve comprising portions of the curve lying within a predetermined thickness of the volume data set is displayed in projected format on the orthogonal MPR image which is
25 substantially normal to the selected direction of the curve.

48. A method according to any one of claims 27 to 47, wherein the projected format of the curves comprises a plurality of graphic markers marking points along the curve, and line segments connecting the graphic markers of adjacent points.

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49. A method according to claim 48, wherein the graphic markers have different designs to indicate the distance through the volume data set of the points from the plane of the orthogonal MPR image.

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50. A method according to claim 48 or claim 49, wherein the graphic markers are movable and deletable to allow the user to redefine the curve.